API Strategy for Enterprise Digital Ecosystem

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***Abstract*— The digital transformation of business is a process of transition to flexible integration of dynamic systems and platforms, defining new ways to organize the process of value creation. We are witnessing the creation of digital ecosystems based on freely and flexibly integrating modules. Based on a review of theoretical and methodological publications dedicated to the tools for building digital ecosystems - application programming interface (API), the concept of API and understanding of it from the point of view of developer, product manager, business analyst is studied. Its importance for the development of the digital ecosystem is commented. The concept of API economy is presented, which is generally used to denote the creation of a new value based on API. The technical and economic advantages and risks of using the API are indicated. The technical and economic advantages and risks of using the API are indicated. The article assesses the importance of the API strategy for business organizations, discusses some strategies for adapting the API in business systems, and provides assessments and recommendations for choosing an API strategy. Key issues are identified and recommendations for API implementation are given.**

Keywords*— *integration, digital ecosystem, application programming interface, API, API economy, API Provider, API Consumer, End User of API, API strategy

I. Introduction

In terms of technology, the digital transformation of business is a process of *transition to flexible integration of dynamic systems and platforms*. In economic terms, it is associated with the development of *new ways of organising the value creation* process based on information and communication technologies and especially on integration tools and platforms [1]. This is a transition from value chains based on a vertically integrated organisation to digital ecosystems centred around freely and flexibly integrated modules. A transition that poses many challenges of a technological and organizational nature.

II. Problem formulation

In this context, a bilateral (from a technological and economic point of view) study of integration is needed as a process of ensuring dynamic interaction of digital environments and systems and generating added value for the participants. [2, p. 3]. The main technological goal of integration is the coordination of systems and participants, and today's main technological tool for this is the application programming interface (APIs). The economic goal of integration is to generate benefits for all participants. When we study the acquisition of value added based on APIs, we are talking about the *API economy*.

Today, several areas stand out with significant potential and results already achieved in digital transformation and the creation of digital ecosystems, including government, services, enterprise, and others. Although the adaptation of APIs has been explored for the digital transformation at the government level and appropriate frameworks exist, there are gaps in its use in business systems and platforms that need to be filled. Good practices, especially in the field of government, can be successfully adapted for different business organizations, so we focus on researching existing API strategies.

For business, the right choice and use of APIs, in the context of the business strategy of the organisation is the *key to new opportunities and improvements in in various directions*. Among them are: improving the business environment; an effective connection between small and medium-sized enterprises with large ones, as well as with the global market; transforming business and relationships and launching new services; development of appropriate skills for the digital economy; finding new sources of growth and employment; increasing competitiveness; increasing the innovation capacity of all enterprises and now especially of small enterprises; finding new ways to create value and increase efficiency; festering construction and offering of products; faster deliveries, etc. [3, p. 11].

This article aims to explore APIs applied to integration in business ecosystems, explore their nature, opportunities, problems and challenges and to provide assessments and recommendations for a successful enterprise API strategy.

III. Methodology

Based on a review of theoretical and methodological publications dedicated to the tools for building digital ecosystems – APIs, their economic potential, as well as their importance for the digital ecosystem, the article examines the strategies for adapting APIs in business systems and provides assessments and recommendations for a successful enterprise API strategy. When choosing strategies for analysis, we aimed to cover a variety of points of view - scientific, corporate, government.

IV. Analysis

A. API concept

The concept embedded in the API is not new. The term application programming interface – API, was first used in the distant 1968 with the meaning of a framework or library for a specific programming language [4]. In a broad sense, APIs are software tools that allow communication between computer applications [5]. In particular, „*the API is an interface that provides programmatic access to*

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service functionality and data within an application or a database" [6]. The API is used to interact between software applications, smart devices, and humans. As a result of their use, the infrastructure of business organisations is changing from the use of monolithic local software to cloud-based applications and orchestration of microservices [7].

As a technical tool for transmitting data flow between components in a digital environment, APIs are based on a set of protocols that regulate the communication between software components and thus, ensure interoperability between the various actors (private and public enterprises, etc.). The protocols define the type of data that can be retrieved, as well as the form and manner of submission of information.

It should be noted that, at this stage, there is no consensus among scientists and professionals on who should define APIs and whether they should be standardised. In this regard, the EU encourages companies to make greater use of open, standardised, and well-documented APIs. It is widely believed that the adoption of open and standardised APIs by companies and developers will stimulate competition and encourage innovation, including in the field of artificial intelligence and IoT [8].

Different points of view contribute to clarify the nature of the API [9, pp. 11-12]. For example, for the developer or system architect - API is a set of functions provided by an installed or web application, some host or other software component; for the product manager – API is an opportunity for the company's applications to share data and functionality with other internal and external applications for the organisation, as well as for integration with business partners, customers, and users; for executive or business analyst – APIs are identified by the value being created.

B. *The importance of API for the development of the digital ecosystem t*

In the documents of the World Economic Forum from 2019, the digital ecosystem is considered as „*consist of interacting* organizations *that are digitally connected and enabled by modularity and are not managed by hierarchical authority (like in a supply chain)*" [10, p. 14]. Valdez-De-Leon gives the following definition of a digital ecosystem – "*loose networks of interacting organisations that are digitally connected and enabled by modularity, and that affect and are affected by each other's offerings*" [1, p. 44].

The goal of the digital ecosystem is to bring together many and diverse actors to create value (directly or indirectly) for the end user. In practice, all participants together create value for each of them, thus becoming interdependent. At the heart of the digital ecosystem are APIs – „*the means of exchanging data, functionality, and value across the digital ecosystem in the modern economy*", carry out the interaction between the individual application systems and „*enable developers to modularly recompose data and functionality for new uses*" [11, p. 4].

The importance of the API for the development of the digital ecosystem is emphasised by both the scientific community and businesses. APIs are at the heart of digital ecosystems and are crucial for each of its key elements - platform, network effects; market expectation [1].

According to Weir, APIs support the creation of new ecosystems. Added value is obtained from the creation of new products and services, for which purpose through the API foreign digital assets are used and combined [12]. API „*revolutionizing traditional business alliances and partnerships through scalability, flexibility, and fluidity*" [13].

A study of Google Cloud and Oxford Economics among 1000 CIOs, conducted in early 2020 [11] found that business organisations that use the API give a very high rating to their role in implementing digital innovation. The results of the study also show that those who use the API in comparison with those who do not use it believe that their relationship leads to agility (42% vs. 25%), automation (53% vs. 26%), and employee productivity (49% vs. 33%). According to the same study, APIs are identified as the most important factor for a successful business partnership because of their importance for developer relationships (55%), customer relationships (51%). [11, p. 9].

C. *API economy*

The presentation of the participants in the API value chain would contribute to the clarification of the API Economy concept (see fig. 1). They are:

- API Provider – owns and exposes certain assets as services and provides them for use through the API under certain conditions.
- API Consumer – is a Developer that uses an API to construct an application through which the end user accesses the provider's assets.
- End User – has access to the application provided to him and through which he actually uses the API and gets a new value.

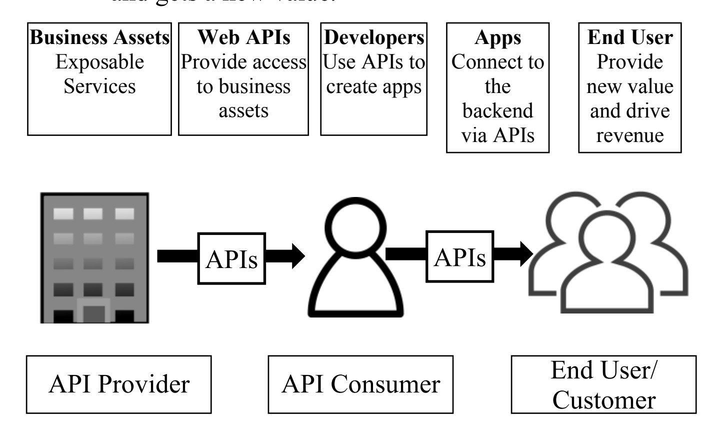


Fig. 1. The participants in the API value chain

Source: [14] p.4

According to Gartner's vice president, K. Moyer "*The API economy is an enabler for turning a business or organization into a platform*". These platforms provide opportunities in business ecosystems, on one hand, to match the interests of consumers and partners, and on the other hand, to facilitate the creation of new products and services. In both cases, value is created for all participants [15]. The economic potential of APIs to create value by providing new services and products and the opportunities

to increase their profitability gave life to the concept of "API economy". There is still insufficient research on the API economy among both academia and business professionals, but the view is that the goal of any API implementation initiative should be to create value for API users [12, p. 3].

The benefit that can be realised through API access to the information assets of organisations is a major source of value. API connectivity of mobile devices and applications, as well as IoT devices, increases efficiency as a result of optimising business processes and using different digital channels. In addition, the API itself is a commodity that generates value for the API provider.

The API economy model includes three key players: API providers that display their business assets (products, services, and data) through the API; API users - businesses that take advantage of one API or a combination of APIs to develop new products, services, and other results; end users.

The components of the API economy [16], i.e. potential sources of added value, can be systematised in several directions: new technologies and social tools, which include Web APIs, mobile applications, social networks and social commerce; business models for providing APIs which range from free to paid; participants in the business model - providers (companies offering APIs), consumers (companies using APIs to offer new products and services), as well as end users (end customers of APIs).

D. Technical and economic advantages and risks of API

Technical and economic advantages of the API can be systematised as follows [12], [17], [18], [19]:

- provide opportunities that facilitate *the transition to modern architectural solutions* [12, p. 60];
- provide a high degree of technological and organisational flexibility and alternativeness of the components of the digital environment;
- provide access *to various platforms and devices*;
- facilitate *internal and external interactions* in the digital environment;
- contribute to *the security* of systems because they determine the type of connections between systems and participants and allow control of the interaction between participants and systems;
- provide *interoperability* of applications and systems (some of which are inherited), reduction of operating costs, increase in sales;
- realise the effects of *information sharing* within and between companies such as: improving internal integration and rapid data exchange between different departments and teams in the company or as a result of better use of internal data flows; optimisation of existing processes; integration with the systems of third countries - partners, external developers, etc.;
- stimulate *innovation*, especially in the following three dimensions: *service delivery* (multi-channel access, access to functionality, charge on subscription or transaction bases); *client interface* (end-customer access, support on user authentication); delivery system (product complementarity; revenue sharing); *technology* (security, stream connection) [18, p. 3];
- are a tool for *developing new business strategies;*
- *stimulate cooperation* at different business levels [19];
- *generate new sources of revenue* as a result of API access to corporate information assets;
- *reduce the cost and time* to develop APIs by reusing existing ones, as well as by reusing business functionality; as well as a result of improved business processes;
- means for *compliance with regulatory requirements and regulations.*

The main risks when using the API are:

- security risks associated with increased vulnerability when systems are freely connected through the API without taking into account the specific conditions of the environment and often blind trust in the API by users;
- inappropriate choice of APIs, as in most cases they are applied to solve a technological problem and lack a business context;
- lack of approaches for evaluation and selection of public APIs;
- lack of a common strategy for their use in organisations;
- lack of regulations for their implementation, etc.

E. Types of APIst

From an architectural point of view, APIs are components in a modular industrial architecture. They can be open (public) or closed (internal) depending on which users they are available to. Only internal users have access to closed APIs, while open ones are available to all external users. When integrating internal systems APIs are defined as internal and respectively – external, when they integrate external ones. External can be partner’s APIs.

From a technological point of view, there are many solutions that can be used. The most established are SOAP, REST, gRPC and GraphQ.

Web APIs include public and affiliate APIs. Open public APIs are available to everyone, while partner APIs are available after signing a partnership agreement.

Depending on the functionality they implement, APIs are classified into the following main groups [12, p. 31]:

- for system connectivity – the main group of APIs that provide access to corporate information assets;
- for corporate mobility – APIs that provide access of mobile devices and applications to business processes and other business opportunities;
- for corporate mobility and productivity – a group of APIs that provide an opportunity for businesses



to offer goods and services to customers through multiple digital channels;

- for collaboration – APIs that allow collaboration between business organisations by optimising and simplifying business transactions;

Depending on the functionality with which they connect can be mapping API, communication API, and billing API and others.

There are two approaches to API development - bottom-up or top-down.

V. Discussion

The purpose of the article is to review the proposed API strategy, as an area of intersection between technology and business. APIs must meet two main requirements: choosing the right technology platform; the chosen platform to support the strategic goals of the business (fig.1).

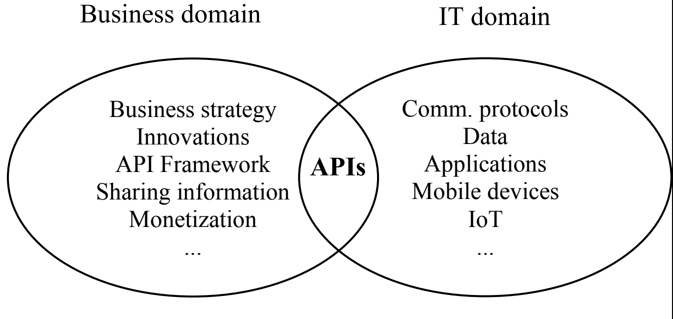


Fig. 1. API – intersection between technology and business

Source: Adapted from a paper by [20]

Organisations need to define a clear API strategy. This strategy will be the basis for effective and long-term business solutions using the API for business needs. In addition, the ability for an API strategy to focus on an API as a "product" will allow the business to operate more efficiently through the development and implementation of an API. The success of this strategy will ensure the development and marketing of new initiatives [21].

Being key building blocks of the digital ecosystem, APIs determine the crucial importance of a well-defined API strategy for the "viability" of the entire digital ecosystem. In this regard, the strategy must include an in-depth study of the markets that the digital ecosystem will include [1].

In the studied literature, we find visions representing the API strategy from different points of view. We present five strategies that define guidelines for building an API ecosystem and its integration into the enterprise digital ecosystem. The first strategy is presented by a researcher, the second, third and fourth are the views of large business companies offering API services, and the last was proposed by the European Commission to assist member governments.

The strategy should include business-oriented activities, but also technical aspects. Regarding the technological side, the used platforms, technologies, and tools are highly dependent on the specific case, therefore, the business aspects are leading.

TABLE I. API Strategies

No	Main guidelines	Description	Source
1	1. Define the business objectives of the API 2. Examine internal and external market and business environment study 3. Identify API users 4. Risk analysis 5. Define business cases 6. Choosing the right business model 7. Estimate and manage API costs and budget 8. Define patterns of business activity 9. Define the marketing strategy 10. Define the strategy for support API consumers	An API strategy based on the ITIL (Information Technology Infrastructure Library) industry framework is described, which applies a process approach to the description of services. Indicates the goals, activities, input and results. This is a broad-based strategy. The authors say that the set of proposed rules can be used as a starting point for business and is not mandatory.	[22, pp. 22-28]
2	The main steps in API planning: 1. planning the API platform and infrastructure; 2. choosing the infrastructure; 3. implementing the API strategy.	The choice of the right API platform, together with the appropriate support infrastructure, is crucial for the implementation of the API program. For this purpose, the functions and services of the API platform are outlined. The main considerations and key parameters in the choice of infrastructure are described. The development of the strategy emphasises the participants in the value chain, the classification of APIs, and ensuring that the interfaces are used by the right customers.	Deloitte [23]
3	The emphasis is on several key business drivers: speed, reach, Internet of Things (IoT) or devices, domains. A business strategy worksheet has been formulated to be used for documenting the main business goals and determining the audience according to the criteria: priority time frame, internal sponsor, API audience.	Business-level issues need to be addressed before API planning. In this regard, the emphasis is on speed, as an element that will allow changes to core IT systems to be done faster, and core enterprise systems more slowly, so that there are no interruptions or security problems. The second - reach means using the API to reach new markets and attract new customers. IoT or other devices can be used in conjunction with the API to provide innovative solutions. Domains are treated as physical locations involving data centers that use a data-sharing API.	IBM [24]
4	Features that the API strategy should include: 1. Access to corporate functionality using a reusable API. 2. Opportunity for innovations implemented with digital applications based on a cloud platform and creation of new channels. 3. APIs have to provide secure and controlled	The proposed opportunities are aimed at companies that actively use cloud infrastructure. It is emphasized that before an enterprise can implement its API strategy, there must be an API lifecycle management platform.	Cloud Standards Customer Council [25]

	access in a hybrid cloud environment, and open APIs in a public cloud environment have to provide access via mobile or IoT applications. 4. Creating an ecosystem with a community of developers to publish APIs and partners to consume APIs outside the enterprise. 5. Monetising data and algorithms and offering new business models.		
5	The Joint Research Center at the European Commission proposes an API framework that includes three levels of action: strategic, tactical and operational. Each level includes four pillars: policy support, platform and ecosystems; people; processes.	The strategic level supports the policy; the tactical level (e.g. department) aims at allocating resources; the operational level is the one at which APIs are applied. The pillars show the possibilities for action by the respective government. For each pillar, for each of the levels is defined one action, a total of 12 to be performed.	European Commission, Joint Research Centre [2]

The first strategy, authored by Remencius and Succi as university researchers, is one of the most comprehensive strategies that can be implemented by enterprises. However, it can be added that in addition to identifying API customers, API vendors and developers who are a party to the digital ecosystem are also essential.

Business companies offering API solutions also have publications on this subject. An example of this is the publication by Deloite (No. 2) and IBM (No. 3). Deloite focuses on the basic steps in API planning, and IBM focuses on key business drivers for the API. Given the rich experience of these companies and the accumulated extensive user experience, these are probably the key issues to be addressed in the API Strategy.

The strategic guidelines presented by the Cloud Standards Customer Council (No. 4) are closely focused on cloud infrastructure. Emphasis is placed on the connection between applications running in a hybrid cloud with an API and providing access via a public cloud.

The API framework proposed by the European Commission is the most complete and in-depth one. Although targeted at governments, it can also be successfully applied to businesses, especially those involved in business alliances.

After the research and presentation of the strategic guidelines, we outline some important aspects, in our opinion, and supplement the concepts presented in Table 1.

The API strategy must be subordinated to the business strategy of the enterprise. This requirement is emphasised in some of the strategic guidelines presented in Table 1. The business goal must first be defined, and then the implementation of APIs subordinate to the defined goal must begin. [24].

It is widely believed that the adoption of open and standardised APIs by companies and developers will stimulate competition and encourage innovation, including in the field of artificial intelligence and IoT [8]. Among the main principles related to APIs set out by the European Commission is openness and transparency [2]. An industry standard that can do this is the Open API Initiative (OAI), which is based on open-source software. Formerly known as Swagger, it performs JSON data representation, understandable to non-programmers [20, p. 267].

Approaches to developing APIs are essential to the success of an API project. There are different opinions on this issue, and they can be related to both the API development technology and the business goal. When using the bottom-up approach, the driving forces are system architects and developers. In this case, the emphasis is on the functionality that the API will perform. In the up-to-bottom approach, the goals of the business are leading and the API must achieve them, and the implementation of the API is the next step that must be done. API-first is an approach in which business stakeholders who make decisions should play a leading role; it's not just a technology concept or a developer's concept [26]. As a good example to follow, the European Commission cites the Estonian Government, which "Adopt an API-first policy of enabling things rather than providing things" [2, p. 48].

Self-service APIs are a service that can be used to retrieve data from legacy systems. It registers software applications and determines the ways to transfer data between applications. The IT department has the task of integrating new applications and performing centralised security control and management [21].

VI. Conclusions

The API has become a tool for developing new business strategies and for digital business transformation. In technological terms, digital transformation is a process of integration of digital environments and systems (generation of digital ecosystems), and in an economic context - it is a new business model. The API strategy, as well as the approach to developing the API, must be consistent with the business strategy of the enterprise. In terms of technology, open and standardised API technologies need to be used.

The following conclusions can be drawn:

- The API strategy defines the "vitality" of the entire digital ecosystem and is crucial for its development, access to new markets and innovation.
- The selection and use of APIs should always be considered in the context of the business strategy of the organization, so it is necessary to first define a business goal, and then implement APIs relevant to the specific goal.

The platforms, technologies, and tools are highly dependent on the specific case therefore the business aspects are leading. The API strategy is expected to lead to the choice of the right technology platform, and the chosen platform should support the strategic goals of the business and allow new opportunities and improvements in various



directions. In this regard, a more appropriate approach to API development is the top-down approach.

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